

## 1 Scope

This application note explains how to use the MLX90109 transceiver to obtain 100% modulation of the magnetic field (On-Off keying modulation). The MLX90109 datasheet will help to understand the basic operating principles and specifications before reading this document.

## 2 Related Melexis Products

MLX90109 and MLX90125 (dedicated antenna for MLX90109).

## 3 General Introduction

On-Off keying modulation consists of switching On and Off the current through the transceiver's antenna MLX90109. This can be achieved by switching the modulation pin MODU (pin 4) between  $V_{\text{ModuMin}}$  and  $V_{\text{DD}}$ .

According to the datasheet of MLX90109 transceiver,  $V_{\text{ModuMin}}$  is fixed to 0,8V to get maximum reading performance.

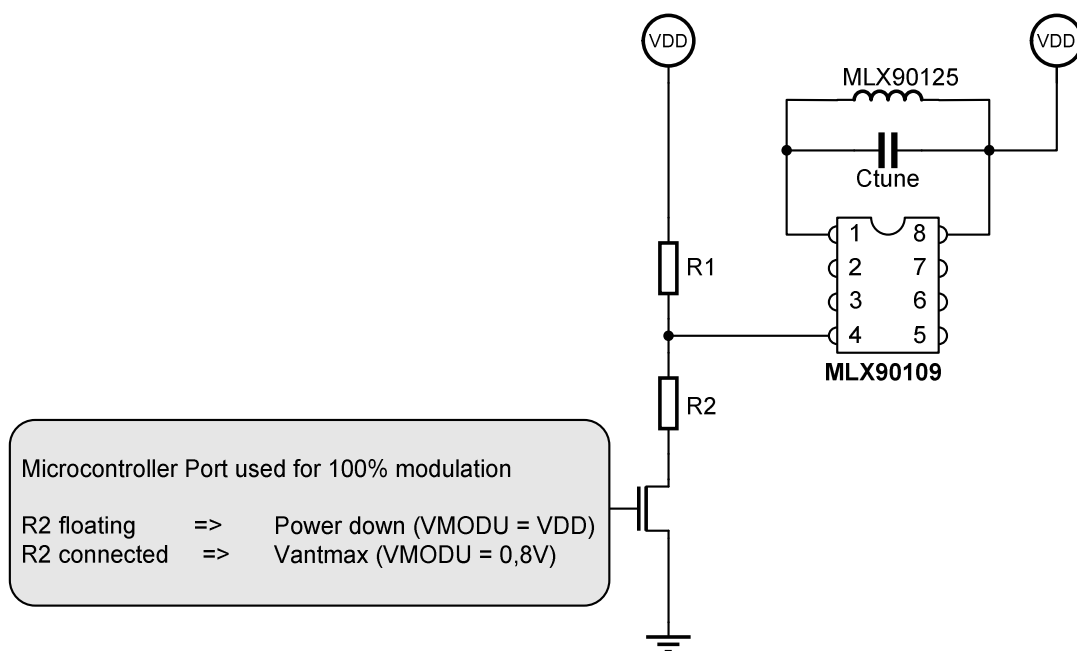
Field Condition	Voltage on Modu pin
ON	0,8 Volts
OFF	$V_{\text{DD}}$

Switching ON the magnetic field depends on the internal driver of MLX90109 and will take less than 5 carrier periods as far as the "Auto Start Up Impedance" condition is respected.

Switching OFF the magnetic field will depend on the quality factor (Q) of the parallel antenna connected to the transceiver. It will take about Q carrier periods in a free swing condition. Depending on the antenna Q and the protocol used, this fall time can be a limitation that will prevent the modulation depth from reaching 100%.

An additional transistor can be used to reduce the fall time of the field and hence insure compatibility with On-Off keying fast protocol.

### 3.1 Application Schematic



Resistors R1 and R2 are calculated to obtain 0,8Volts on MODU pin. High values are chosen to reduce power consumption.

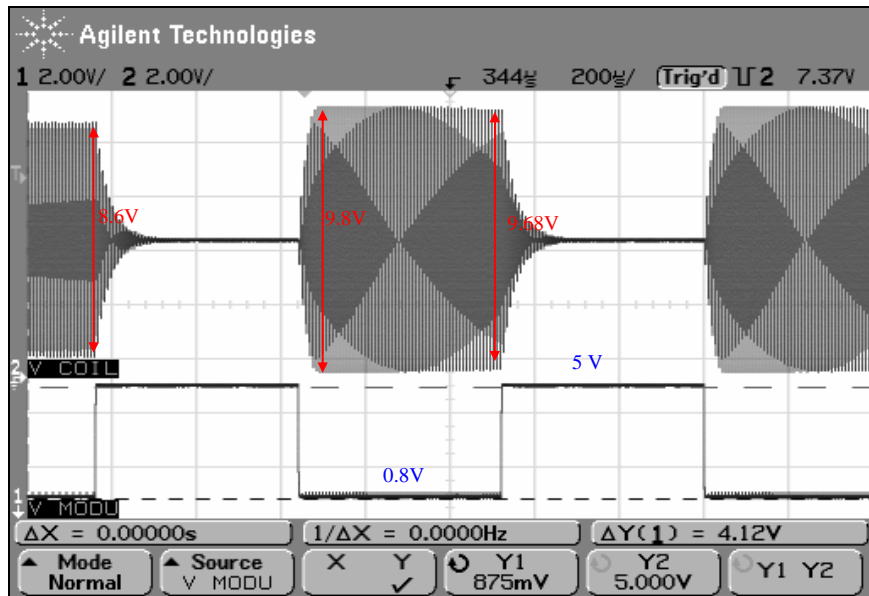
R1	R2
39kOhm	8,2kOhm

The antenna used in the description below has the following characteristics (MLX90125CZA-A)

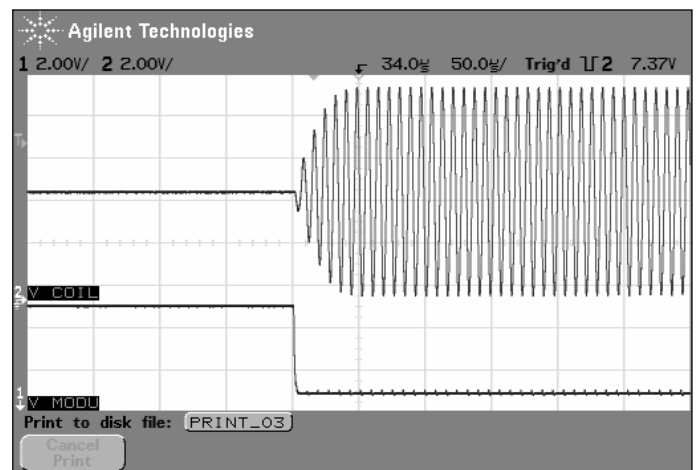
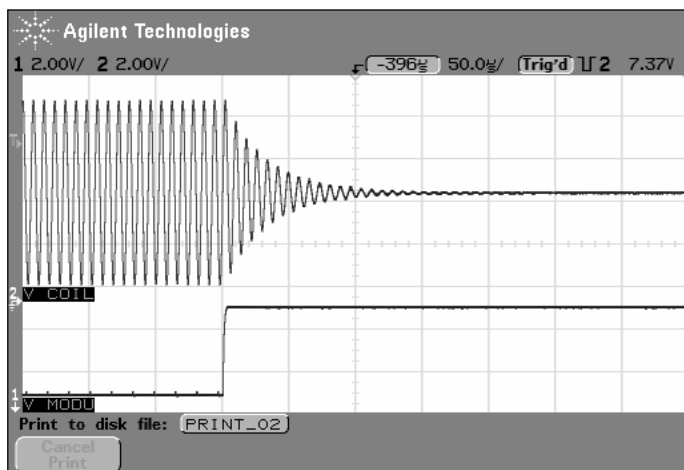
L	Qant	Zant (125khz)	Ctune (125khz)
73,7uH	24	1,4kOhms	22nF

### 3.2 Pictures of 100% Modulation

The picture below shows general behaviour of MLX90109 during a 100% modulation pattern.



The pictures below shows fall and rise time details.



## 4 Reducing the switch-off time of the antenna

### 4.1 Description

Protocols that use On-Off keying modulation (E.g. HITAG protocol) need to shut down the magnetic field pretty quickly, in order to minimize the time during which no energy is delivered to the transponder (E.g. HITAG2 protocol uses field Off pulses of typically 48us).

The fall time with the MLX90109 mainly depends on the quality factor of the parallel antenna. With the antenna MLX90125CZA-A, used for the measurements, the coil swing-out will take approximately:

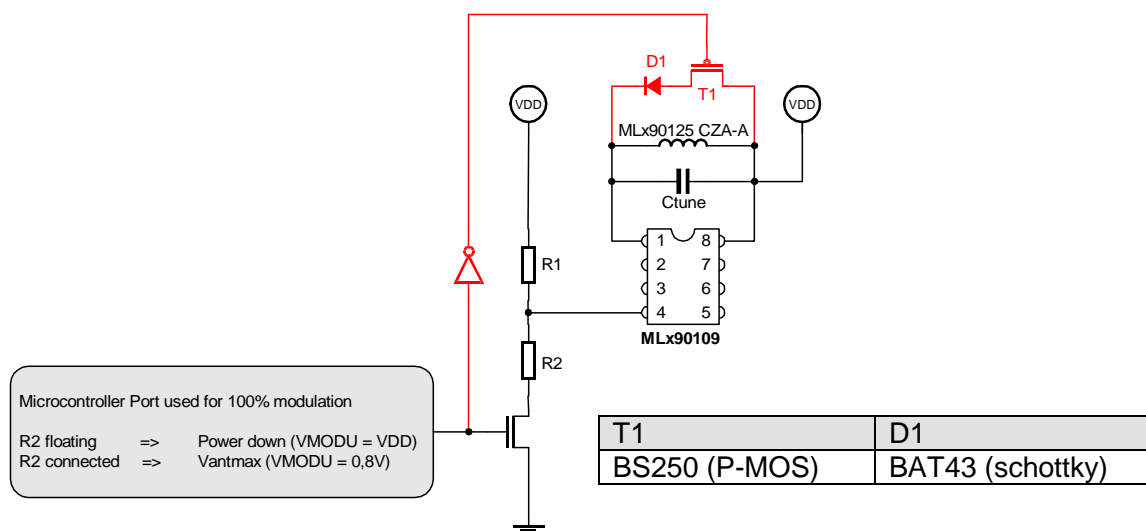
$$t_{shutdwn} = Q \cdot \frac{1}{f_{carrier}} = 24 \cdot 8\mu s = 192\mu s.$$

The application circuit below shows how to reduce the fall time with a transistor and a schottky diode in parallel of the MLX90109 antenna.

### 4.2 Fast decay circuit

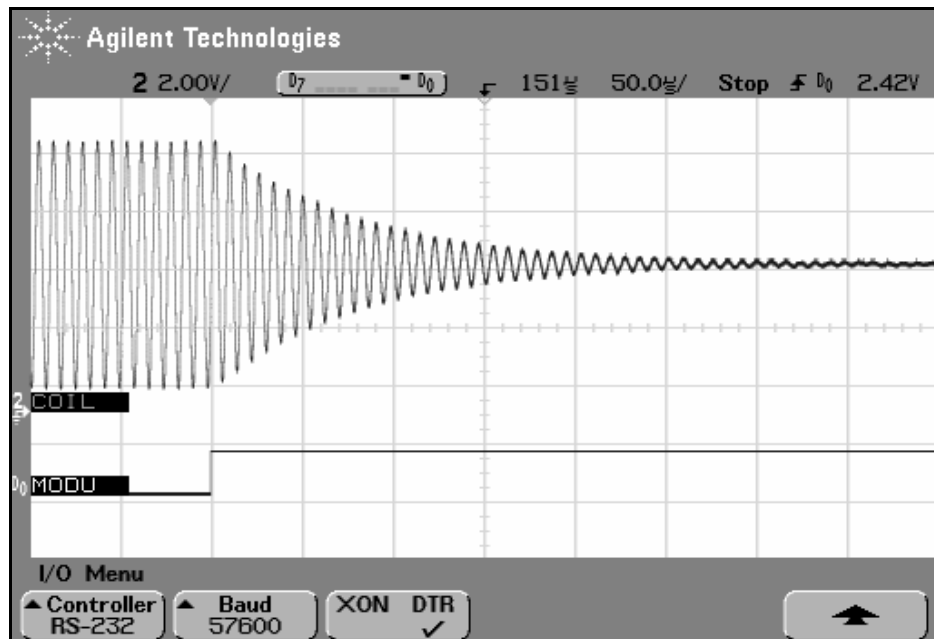
Transistor T1 will be controlled with the inverted command of the microcontroller port used for field management (100% modulation). When Off (5V on the grid), T1 is blocked and the additional system is disconnected from the antenna. D1 avoids conduction of the parasitic diode of transistor T1.

When On (0V on the grid), T1 is open. This will short the antenna for negative swings and dissipate the remaining energy through transistor T1. The fall time will hence be reduced.

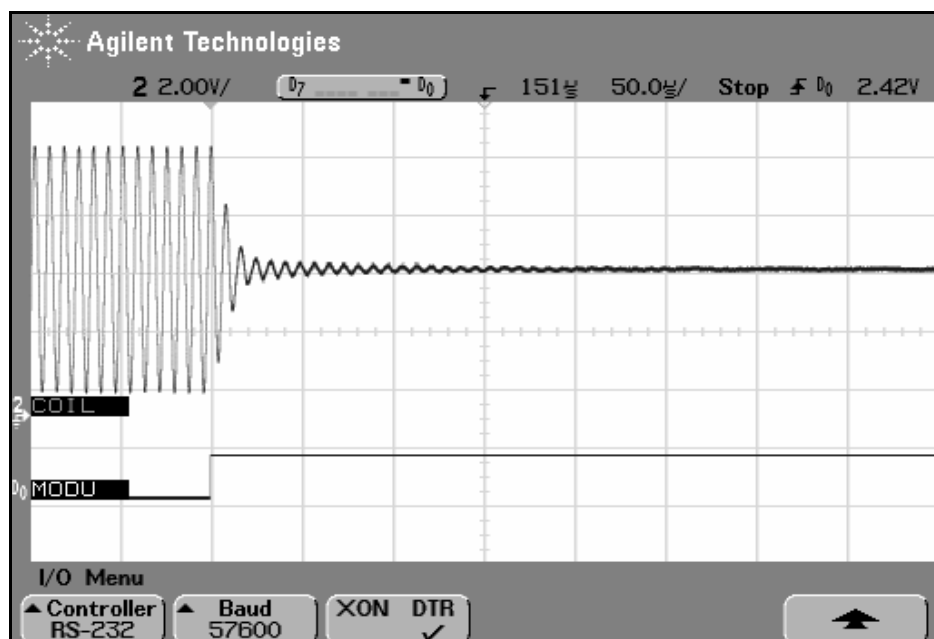


## 4.3 Scope pictures

Fall time without transistor T1 (200us).



Fall time with transistor T1 (20us).



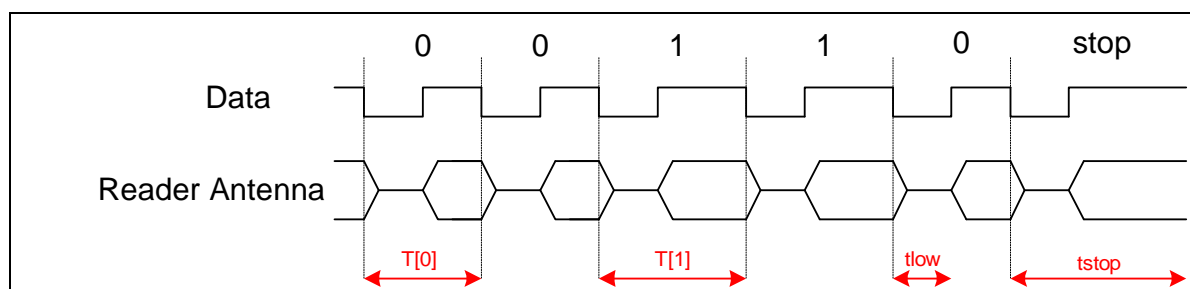
## 5 HITAG2 protocol emulation

### 5.1 Short description

Hitag2 is a protocol based on a reader talk first protocol. This means that the transponder will only reply on request of the reader (START command).

Commands are sent to the transponder by switching On/Off the current through the reader antenna (100% modulation or On/Off keying). Depending if the field is On/Off, these times will be indicated with respectively low and high field.

All data sent by the reader will start with a low field condition. After a fixed low field time the field is switched on again and the length of this high field period will make the distinction between '0' and '1' bit (see table below).



Symbol	Description	Duration	Application configuration
$t_{low}$	Low field time	4 to 10 $T_0$	6 $T_0$
$T[0]$	Logic '0' pulse length	18 to 22 $T_0$	22 $T_0$
$T[1]$	Logic '1' pulse length	26 to 32 $T_0$	28 $T_0$
$t_{stop}$	High field for stop condition	>36 $T_0$	>36 $T_0$

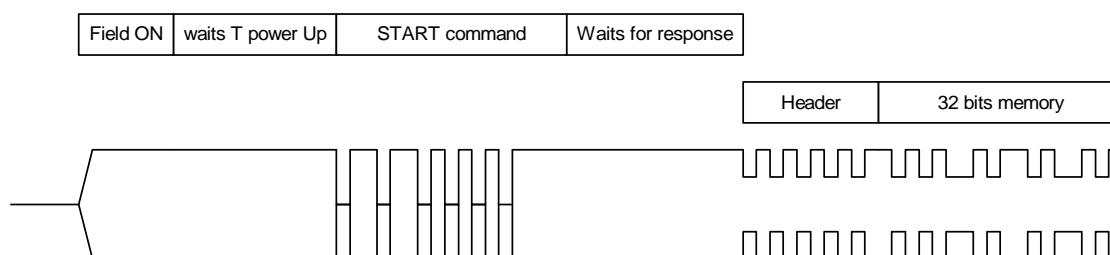
Remark

$T_0$  = Carrier period time =  $1 / 125\text{kHz}$  =  $8\mu\text{s}$  nominal

### 5.2 Communication

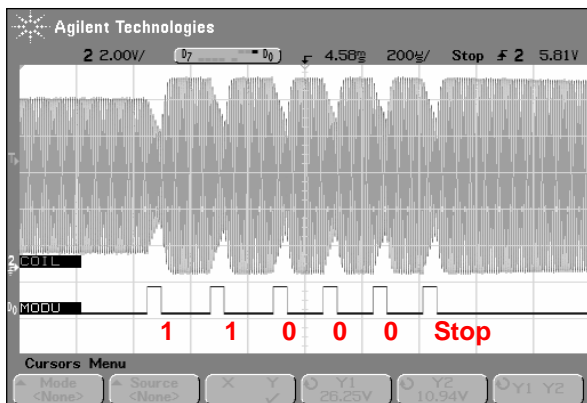
After switching On the magnetic field, the reader must wait  $t_{\text{PowerUp}}$  before sending a START command. The reader sends a START command "11000 + Stop condition" and waits for a reply from the transponder.

After receiving a START command, the transponder will reply in Manchester 4kbaud with a header of 5 bits to 1 followed by 32 memory data bits.

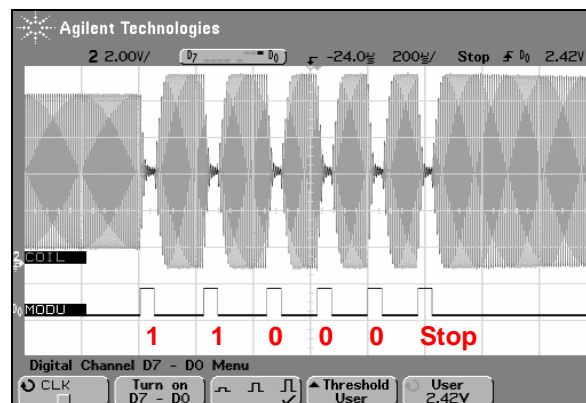


### 5.3 Scope pictures

The picture below shows a START command sent by the reader.



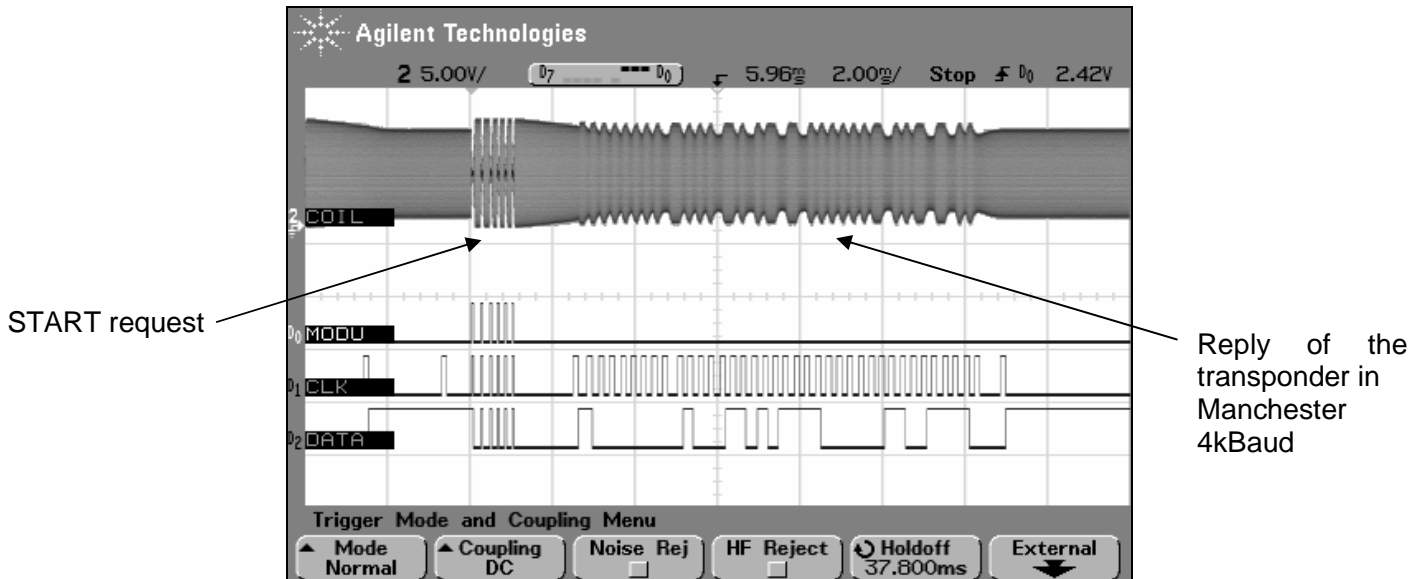
Without fast decay



With fast decay

As can be seen above, the additional transistor T1 allows for a 100% modulation depth with a good switch off time of the antenna.

The picture below shows the response of the transponder measured on the reader antenna after START request.



### Remark:

Some special attention must be paid to decode the data from the MLX90109, especially when the transponder does not send continuously its identification number (e.g. reader talk first applications). For that purpose, please refer to the application note MLX90109, Reading Operation.

## 6 Conclusion

Using two inexpensive components, the MLX90109 is capable to properly manage custom protocols, like HITAG2 that require the use of short period on / off keying.